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UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Griffiths
Serial No.:	09/525,741
Filed:	March 14, 2000
Group Art Unit:	~~3619~~ 3611
Examiner:	Royal, P.
Title: -	AIR SPRING

Box AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REPLY BRIEF

Dear Sir:

The Examiner's answer mailed 09-08-2004 raises several new arguments. These are addressed below. Appellant submits this Reply Brief in order to address selected statements in the Examiner's Answer. The Reply Brief is not cumulative of the arguments in the Appeal Brief. In fact, Appellant has made an effort ***not*** to repeat here arguments already made in the Appeal Brief.

ARGUMENTS WITH REGARD TO BATES "AIR SPRING" ITEM 12 AND "MAIN SPRING" ITEM 11

The Examiner attempts to argue that "Bates teaches two distinct varieties of air cells, item 12, the "air spring" and item 11 the "main spring".

Answer

The Examiner asserts that Appellant has not presented evidence that the term "air cell" has a specific meaning within the art. Initially, the disclosure providing within *Bates* itself differentiates between the "air cell" 12 and the "main spring" 11. That is, the "air cell" 12 and the "main spring" 11 are not both air cells as proposed by the Examiner. [See Examiner's Answer p. 11] Because *Bates* distinguishes between the "air cell" 12 and the "main spring" 11, the Examiner's rejection must fail as the entire foundation for the Examiner's rejection relies on the suggestion that the main spring 11 is a "variety" of air cell as understood in the art.

Bates recites:

> A pair of main springs 11 comprising frustoconical rubber spring having metal end plates bonded to the rubber is mounted between the frame 5 and the vehicle body 1, one being attached to either end of the cross member 9 and both acting substantially vertically to support the vehicle.
>
> *[See col. 2, lines 8-11.]*

The air spring 12 is connected to an air supply by means of an inlet pipe 14.

> A source of pressurized air is supplied to the inlet pipe 14 and the pressure is controlled by means of a control valve sensitive to the height of the air spring.
>
> *[See col. 2, lines 20-22.]*

Bates makes no mention of supplying air pressurized air to the main springs 11. This is completely consistent as the main springs 11 are not air cells as commonly as understood in the art.

Bates also differentiates between operation of the "air cell" 12 and the "main spring" 11:

> In operation, deflection of the suspension due to vehicle weight (i.e. static deflection) causes ***deflection*** of the main springs 11 together with

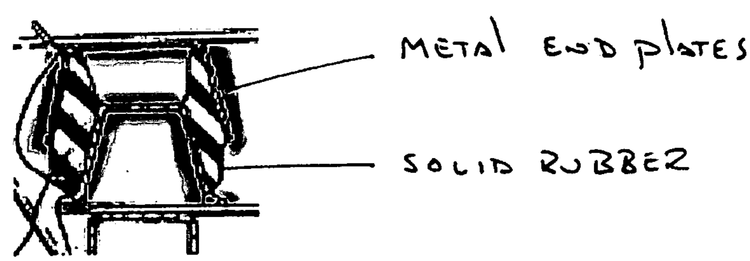
compression of the air spring 12. The leveling valve senses this *compression* and supplies pressurized air to the air springs 12 to cause adjustment of the air spring back to its initial predetermined height.

[See col. 2, lines 31-37; emphasis added.]

Here again, *Bates* differentiates between deflection and compression. A solid rubber member deflects while the air spring is compressed.

Although *Bates* distinguishes between the "air cell" 12 and the "main spring" 11, Appellant has provided additional commonly available evidence through the attached pertinent parts of the reference "Heavy-Duty Trucks: powertrains, Systems, and service" by Robert N. Brady. *[Pertinent parts attached as Exhibit A]*

Although the form of "main spring" 11 is not specifically disclosed within the attached reference, the "main spring" 11 is essentially a rubber-load cushion system. Rubber-load cushion systems utilize solid rubber blocks of various shapes bonded between metal end plates in place of leaf springs to cushion road shocks. *[See Exhibit A p. 749-751; Figures 20-45; and 20-46.]* Notably, the main springs 11 are simply solid rubber members (notice cross-hatching) bonded between frustoconical supporting metal end plates. The solid rubber members are almost completely surrounded by the frustoconical supporting metal end plates.



Such solid rubber suspensions differ greatly from air ride suspension systems that utilized deformable air cells or compressed-air-filled bags or bellows. *[See Exhibit A p. 732-737; Figures 20-13; and 20-17.]*

While it is well settled that terms in a claim are to be given their broadest reasonable interpretation in proceedings before the PTO, this interpretation must be consistent with the specification, with the claim language being read in light of the specification as it would be interpreted by one of ordinary skill in the art. *In re Bond*, 910 F.2d 831, 833, 15 USPQ2d 1566, 1567 (Fed Cir. 1990); *In re Sneed*, 710 f.2d 1544, 1548, 218 USPQ 385, 388 (Fed Cir. 1983). The Examiner interpretation of both the "air cell" 12 and the "main spring" 11 as air cells is not a reasonable interpretation. Appellant respectfully suggests that the Rejection be overturned.

CLOSING

For the reasons set forth above, the rejection of all claims is improper and should be reversed. Appellant earnestly requests such an action.

Respectfully submitted,

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Dated: 8 November 2004

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail, postage prepaid, in an envelope addressed to Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 8[TH] day of November, 2004.

Beth A. Beard

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EXHIBIT A

Heavy-Duty Trucks:

Powertrains, Systems, and Service

Robert N. Brady
Vancouver Community College
and HiTech Consulting Limited

Merrill
Prentice Hall

Upper Saddle River, New Jersey *Columbus, Ohio*

Library of Congress Cataloging-in-Publication Data
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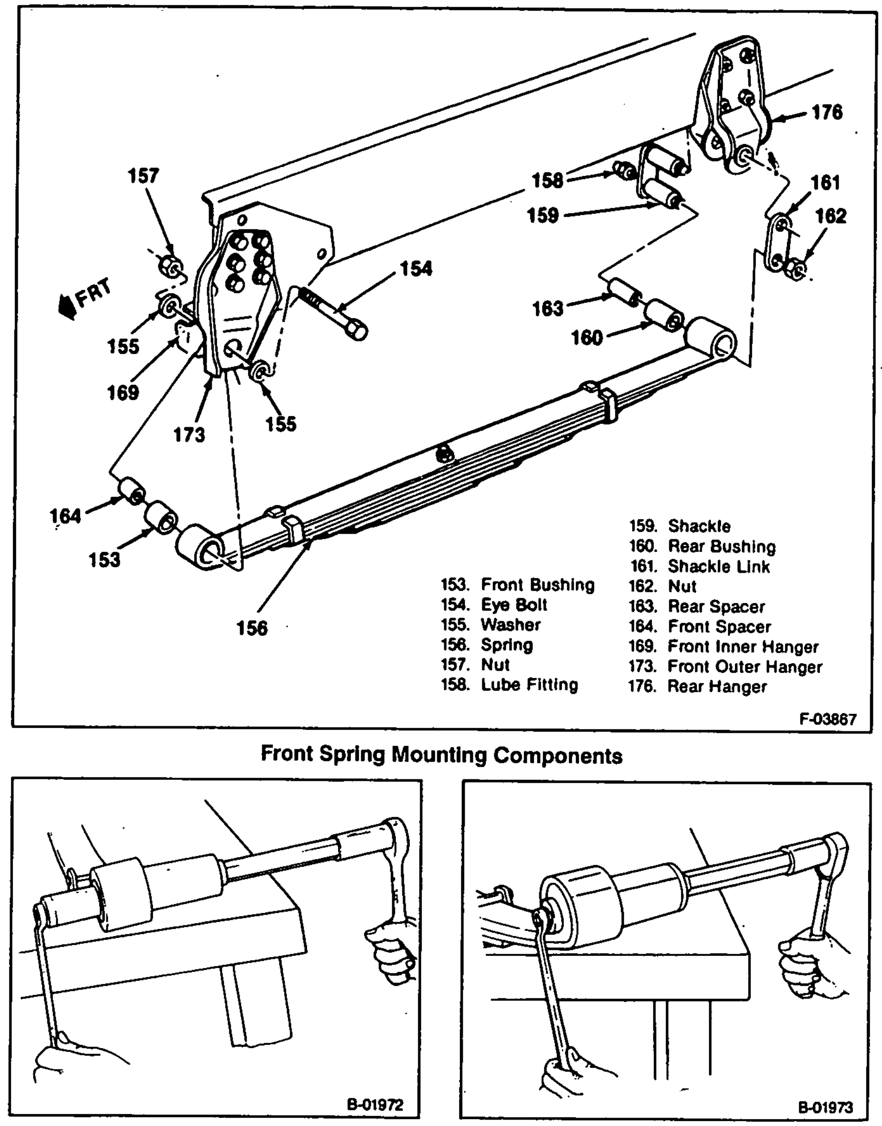


A

Front Spring Mounting Components

Removing the Spring Eye Bushing
B

Installing the Spring Eye Bushing
C

FIGURE 20–11 (a) Component mounting parts of a front-spring assembly; (b) removing the spring eye bushing; (c) installing the spring eye bushing. (Courtesy of GMC Truck Division, General Motors Corp.)

keyway. Drive the draw key in with a hammer and install the lock washer and nut and tighten to specs. Install the lube fitting and pressure lubricate until lubricant appears at both ends of the spring eye bushing.

Spring Caster Shims

Heavy-duty trucks that employ leaf-type spring suspensions on the front-axle assembly invariably require the installation of a steel plate shim, as shown in Figure 16–9 on page 471, between the axle spring mounting pad and the underside of the spring seat. If this shim is removed, be sure to reinstall it when the spring is either removed and reinstalled or when a new spring is fitted. This shim is required to establish axle caster. Refer to Chapter 16 for more details on shim placement and how to check axle caster.

AIR RIDE SUSPENSION SYSTEMS

Air ride suspension systems are extremely popular today on trucks, semitrailers, and buses due to their softer ride characteristics where ride quality both empty and loaded is important. On buses and coaches, the air ride system provides superior riding comfort for passengers. Each major suspension system OEM offers some type of air ride system. Well-known air ride systems are manufactured by Hendrickson Suspension, Neway Anchorlok Industries, Reyco Industries, and Ridewell Corporation, all of which offer outstanding suspension systems for trucks, tractors, trailers, and buses. The concept of operation involves a number of compressed-air–filled bags, more commonly referred to as *air springs*.

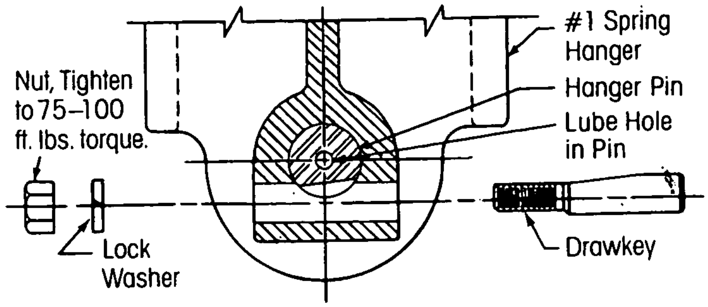


FIGURE 20–12 Aligning the flat on the draw key with the machined flat on the spring hanger pin. (Courtesy of Hendrickson Truck Suspension Systems.)

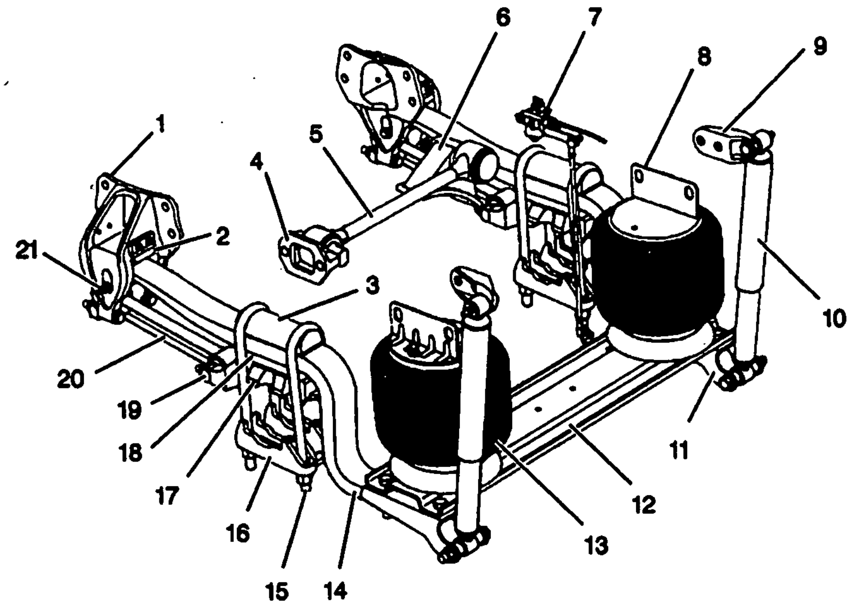
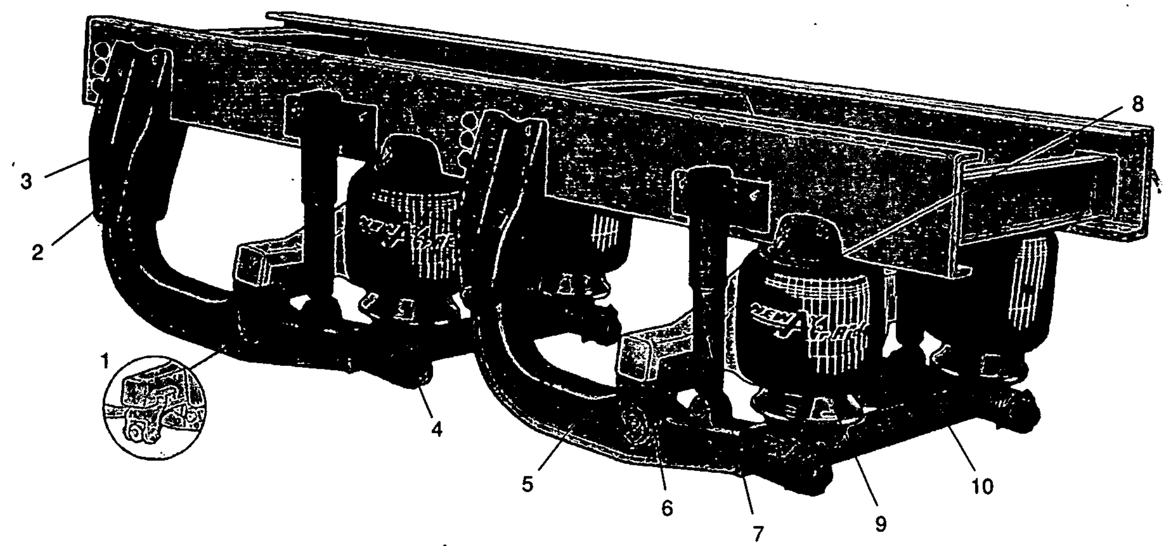


FIGURE 20–13 Components of a single rear-axle air spring suspension system. (Courtesy of GMC Truck Division, General Motors Corp.)

1. SPRING HANGER
2. INSULATOR
3. TOP PAD
4. TRANSVERSE ROD FRAME BRACKET
5. TRANSVERSE ROD
6. TRANSVERSE ROD AXLE BRACKET
7. HEIGHT LEVELING VALVE
8. AIR SPRING FRAME BRACKET
9. SHOCK ABSORBER UPPER MOUNT
10. SHOCK ABSORBER
11. SHOCK ABSORBER LOWER MOUNT
12. CROSS CHANNEL
13. AIR SPRING
14. MAIN SUPPORT BEAM
15. U-BOLT
16. BOTTOM CAP
17. SPRING SEAT
18. DELRIN LINER
19. TORQUE ROD BAR PIN
20. TORQUE ROD
21. REBOUND ROLLER BOLT

Figure 20–13 illustrates the components of a single rear-axle air spring suspension system; for a tandem rear-axle design, Figure 20–14 shows a slightly different design of air spring system employing two similar air spring subsystems. Minor variations exist in the air spring design systems of different OEMs, but the concept is similar. The suspension units are attached to the vehicle frame as shown. In the Hendrickson model, a main support beam, item 14 in Figure 20–13, is fastened to the axle and to the frame. In conjunction with the air springs, this main support beam is used to provide constant ride height empty and loaded, low frame height, and positive axle alignment. Although it may look like a single-leaf spring, its purpose is to transfer axle bounce to the air springs as it pivots at the forward spring hanger. Both Kenworth and Peterbilt as well as Freightliner trucks employ a similarly designed system, which is shown in Figure 20–15. In place of the main support beam, Peterbilt employs a two-leaf spring assembly, and the design is known as an Air Leaf suspension system. Another model used by Peterbilt is the Air Trac system shown in Figure 20–16. The major difference between



1 - Bar pin connection
2 - Front pivot connection
3 - Frame brackets
4 - Coarse thread, nut and locking tab washer
5 - Rigid beam
6 - Beam hanger bracket
7 - HD shock absorbers
8 - Air spring mounting plate
9 - Composite air spring pistons
10 - Super heavy duty transverse beam

FIGURE 20–14 Tandem rear-axle air suspension system. (Courtesy of Neway Anchorlok International.)

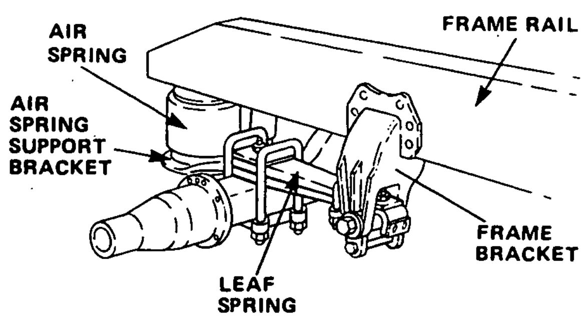


FIGURE 20–15 Peterbilt Air-Leaf suspension system. (Courtesy of Peterbilt Motors Company, Division of PACCAR.)

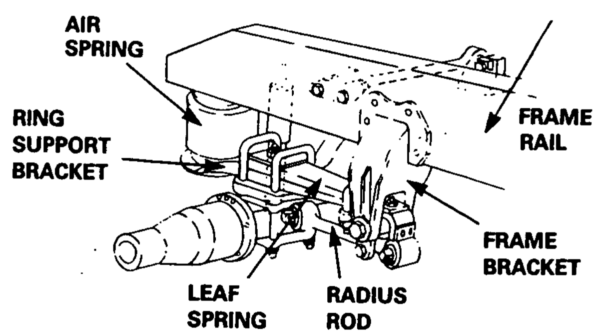


FIGURE 20–16 Peterbilt Air-Trac suspension system. (Courtesy of Peterbilt Motors Company, Division of PACCAR.)

the Air Leaf and Air Trac systems is that the Air Trac model uses a radius rod between the spring hanger bracket and the axle spring seat. Both of these designs employ shims for axle alignment, discussed later in this chapter, similar to that for the Hendrickson models.

On the system illustrated in Figure 20–16, the torque action on the suspension system as a result of vehicle motion is absorbed through the radius spring leaf. The rear-axle alignment is made by shims at the frame spring brackets, where the radius spring leaf is attached. Steel-backed rubber bushings are pressed into the radius spring leaf eyes and are bolted to the frame spring brackets. A steel rebound bolt is located in each frame spring bracket. This pin stops the main spring from slipping out of the bracket.

Other air spring systems used in both on- and off-highway applications for heavy-duty trucks do not use a main support beam like the model shown in Figure 20–13 (item 14), but use instead a rigid beam that is said to be more durable than leaf springs. This rigid

design, shown in Figure 20–14, maintains axle pinion angles and reduces spline and U-joint wear, along with driveline chatter.

The growing popularity of air ride suspensions has made maintaining U-joint angles very important. Ride height does not change with spring suspensions; with air ride designs, however, if the leveling valve setting is changed, ride height and driveline angles can both be affected. This can cause noise and vibrations from the U-joints. Air suspensions can also enter the equation for rear-axle choices, although transmission choice and tire size tend to be larger factors in model and ratio selection. With electronic engine controls, the use of smaller tire sizes—19.5 in. (495 mm) versus the long-used standard of 22.5 in. (572 mm)—and faster overall axle ratios, fleets can take advantage of a lower ride height and increased cube provided by the smaller tires. Figure 20–17 shows the mechanics of two different types of Airide springs.

Air Control System

The suspension air control system uses air drawn from the vehicle compressed-air reservoirs to pressurize the air springs. Figure 20–18 illustrates a typical air system used with an air spring suspension. A dash-mounted control valve similar to the example shown in Figure 20–19 allows the operator to lower or raise the rear-axle suspension when connecting or disconnecting the tractor from a trailer system.

A pressure protection valve located on the front reservoir protects the system air supply to the brakes should a suspension system air spring rupture or a supply line be ruptured. An air suspension relief valve permits deflation of the air springs when the operator manually moves the dash-mounted control valve to the exhaust position. This valve operates in conjunction with a system height control valve discussed below.

Air springs are equipped with internal rubber bump stops for safety reasons. These stops are shown as item 7 in Figure 20–17 within the air springs, as well as in Figure 20–20. If underinflation is experienced or a loss of air is encountered, the suspension system weight will be carried on these stops until a repair can be made. Do not operate a loaded vehicle or trailer on the bump stops for any extended period of time, however, except to move the unit to a repair facility. When a rough ride complaint is lodged by an operator, either too much or too little air in the air springs could be the reason. Check the air pressure in the bags. Figure 20–20 illustrates a properly inflated air spring and also one that is underinflated; Figure 20–21 shows the difference between a properly inflated air spring and an overinflated unit.

Ride Height Adjustment

The suspension system ride height is maintained by the use of a height-leveling valve located on the frame and attached to the cross channel by a fixed link. Figure 20–22 illustrates the ride height leveling valve, which senses changes in the vehicle chassis ride height due to varying loads and either adds or exhausts compressed air from the air springs until the correct ride height is obtained.

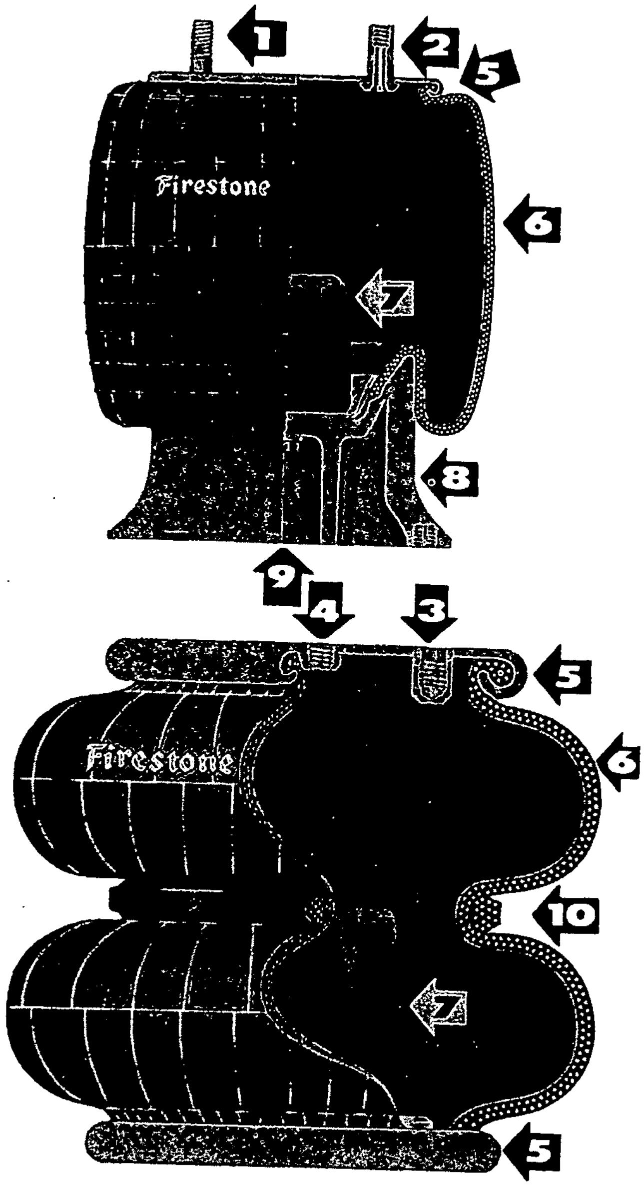
The ride height for the suspension system can be adjusted by loosening off the threaded extension arm fasteners and turning the ends, or by loosening the leveling arm locknut and repositioning the arm within the elongated hole in the arm. The ride height valve and the in, out, and exhaust ports are shown in Figure 20–23. The arc of travel of the ride height control valve will vary among specific makes and models of systems; one example is shown in Figure 20–24 for a Hendrickson HAS 40LH air suspension model. Note that in Figure 20–25, the recommendation is specified to allow a free-travel or dead-band range of $\frac{3}{16}$ in. (4.76 mm) both sides of the horizontal lever position. This is approximately 3° to 4° of travel before air is allowed to pass. Less dead-band travel than this will constantly have the air springs inflating and deflating.

To check the leveling valve for correct operation, move the lever downward briefly, then upward approximately 2 in. (50.8 mm); then start counting how many seconds it takes before air starts to flow through the valve. A typical delay period is 2 to 9 seconds, although some models specify 3 to 10 seconds, which confirms that the valve is functioning correctly. To check for proper exhaustion of compressed air from the air springs, briefly move the leveling valve lever upward, then push it down and time how long it takes before air starts to escape from the exhaust port. If it is within 2 to 9 seconds, the valve is functioning properly. Slow operation can be caused by a clogged screen in the inlet adapter fittings and ports. If the bags will not inflate, check

- Air supply at the height control valve
- For air passing through the valve when it is actuated
- For blockage or a pinched air line to one or more air bags
- The height control valve to ensure that it is set correctly

Trailer Slider Air Ride System

Most Class 8 truck/tractors are equipped with a sliding fifth wheel (see Chapter 22) to allow for weight distribution between the tractor and trailer axles, based on the type of load being hauled (grossed-out versus cubed-out). Trailer suspension systems are



1 STUD

Manufactured as a permanent part of the bead plate assembly. Used to attach spring to suspension.

2 COMBO STUD

Serves dual purpose of mounting the spring to the suspension and providing an air entrance.

3 BLIND NUT

Also a permanent part of the bead plate assembly. An alternate mounting system to the stud.

4 AIR FITTING

Usually ¼ N.P.T. Provides air entrance for the part.

5 BEAD PLATE

Crimped on to the bellows at the factory. A permanent part of the bellows allowing complete leak testing before the unit leaves the factory.

6 BELLOWS

The heart of the airspring. Includes at least four plies or layers of material — an inner liner, two or four plies of cord reinforced fabric, and outer cover.

7 BUMPER

Solid rubber fail safe device used on many truck suspension applications. Prevents excessive damage to vehicle and suspension in the case of sudden loss of air pressure in the spring.

8 PISTON

Lower section of the 1T and 1X styles. Usually made from aluminum, steel, Fiber Glass, or hard rubber. Provides lower mounting arrangement for the spring in form of tapped holes or studs. Held to the bellows by the attaching bolt.

9 PISTON BOLT

Attaches piston to bellows assembly, and in some cases is extended to serve as means of attaching spring to the suspension.

10 GIRDLE HOOP

Ring between the convolutions of the convoluted type springs helps to provide lateral stability. Older models use loose steel type ring, newer units use a specially designed wire-wound arrangement molded into the unit.

SERVICE ASSEMBLY

On Firestone Airide springs of the 1T style the rubber bellows bead plate portion of the spring is a separate hermetically sealed unit. It is available for replacement use without the piston. Called a service assembly, the replacement unit includes bead plate, bellows, internal bumper (if any) and all attaching hardware facilities.

FIGURE 20-17 Construction and features of an Airide spring unit. (Courtesy of Firestone Industrial Products Company.)

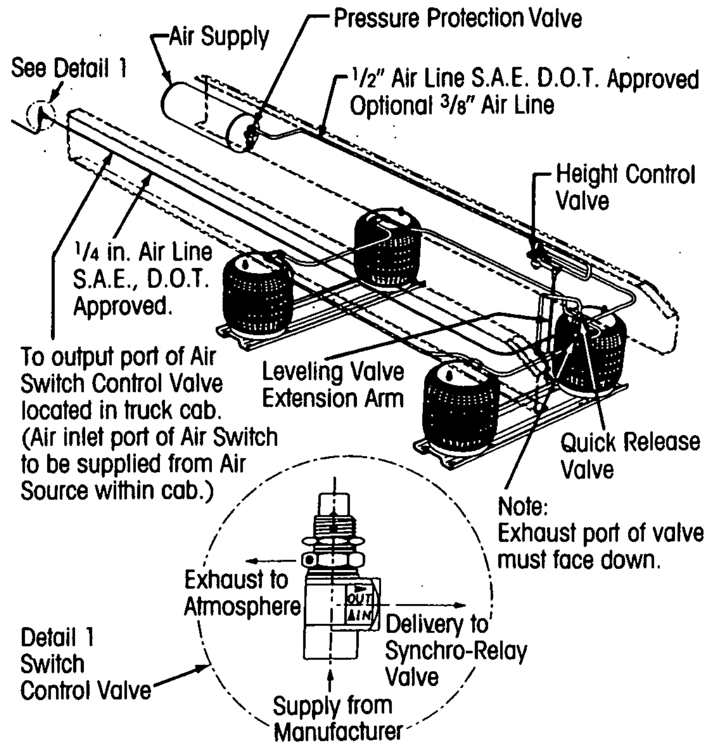


FIGURE 20–18 Typical air plumbing diagram for an air ride suspension system. (Courtesy of Hendrickson Truck Suspension Systems.)

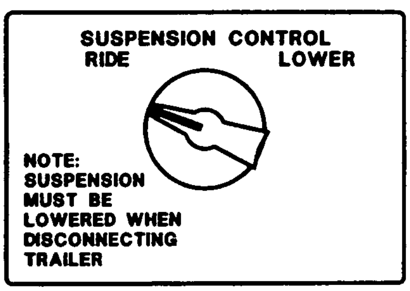


FIGURE 20–19 Example of a dash-mounted heavy truck air ride suspension system control knob. (Courtesy of Volvo GM Heavy Truck Corp.)

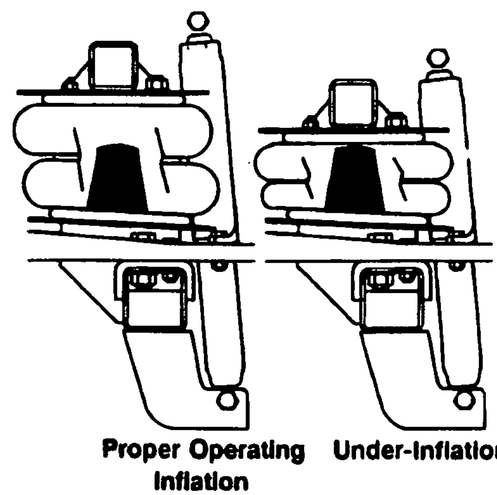


FIGURE 20–20 Comparison of a properly inflated and an underinflated air spring. Note the solid rubber bumper stops to carry the suspension/vehicle weight when an underinflated condition exists. (Courtesy of Hendrickson Truck Suspension Systems.)

trates the special OTC tooling adapters required to place pressure on the bushing outer sleeve to force it safely from its bore.

With the bushing removed, clean and inspect the beam bore area for signs of damage. Using an OTC 1764 bushing remover and installer tool, press the new bushing (15) into place exerting force on the outer sleeve until the bushing extends an equal distance through the beam (22) at both sides. Refer to either the truck OEM's service manual or to Hendrickson's own service literature to obtain the required bolt and nut torque values for the specific type and model of suspension system equalizing beam being used.

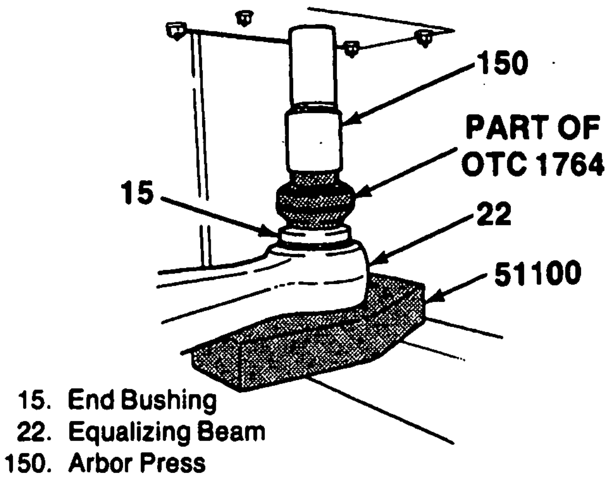


FIGURE 20–44 Replacing the equalizing-beam end bushing using a hydraulic press. (Courtesy of GMC Truck Division, General Motors Corp.)

RUBBER–LOAD CUSHION SYSTEMS

An extremely popular type of equalizing-beam design suspension system used in both on- and off-highway applications is the rubber load cushion design. Widely used in refuse, redi-mix, dump, and logging vehicles, solid rubber load cushions provide excellent stability for heavy loads and high–center-of-gravity operations. Figure 20–35 showed an example of a Model RS rubber–load cushion system; Figure 20–45 illustrates an exploded view of this same system.

The RS series suspensions use four rubber load cushions in place of leaf springs to cushion road shocks. These cushions are available in several durometer hardness readings to suit specific applications and loads. Different color codes are used along with a part number molded in a circular medallion on the flat end of the cushion to help identify different cushion deflection rates and loads.

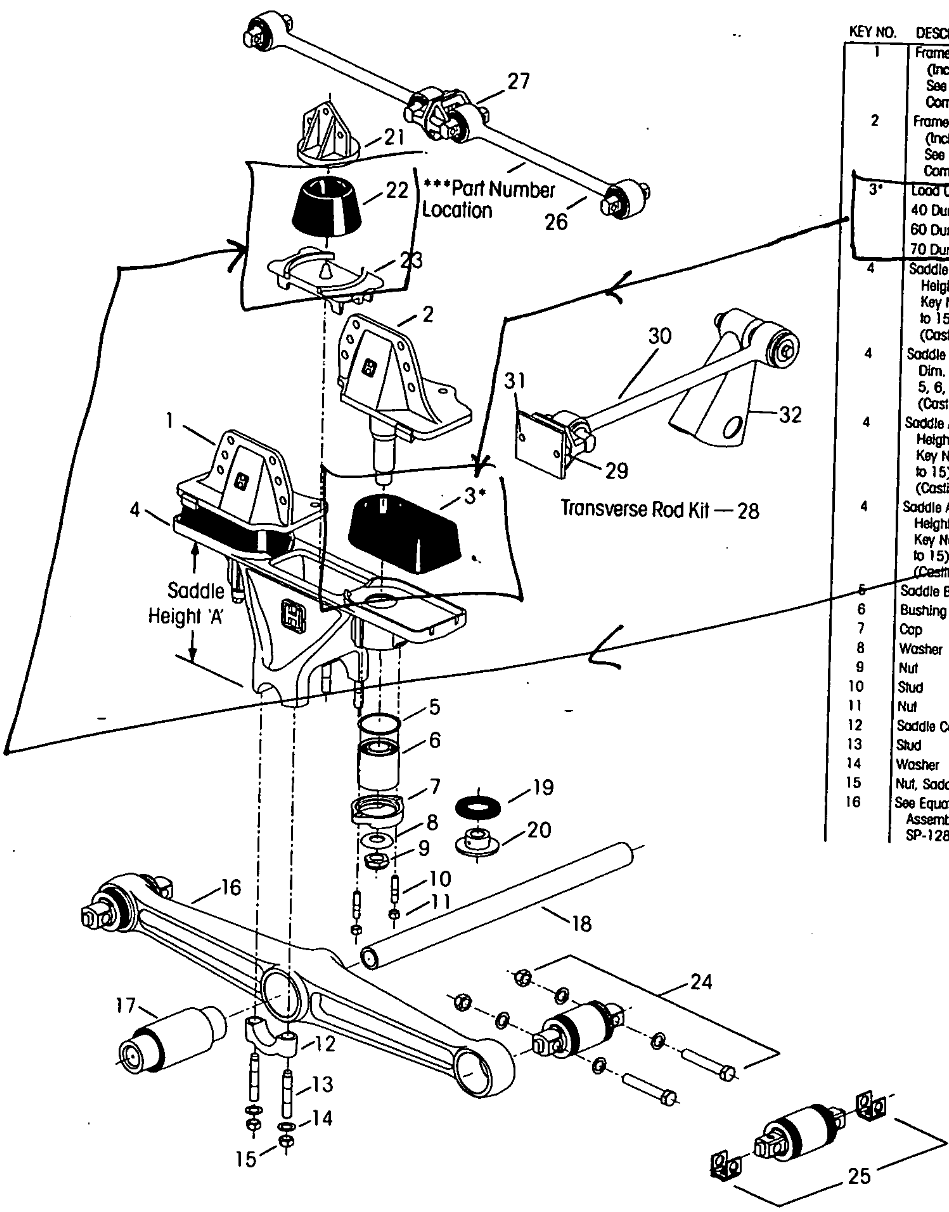
Each cushion has an inner cross bar that helps to support the load when the vehicle is loaded, as shown in Figure 20–46; an empty vehicle is supported only by the outer edges of the cushions, which is also shown in this same diagram. Note that the support hangers above each cushion are attached to the vehicle frame. The hangers have vertical drive pins that extend down through the load cushions and are secured to rubber vertical drive bushings in lightweight aluminum saddles. All driving, braking, and cornering forces are transmitted through these pins. These vertical drive pins, shown in Figure 20–47, allow the saddles to move up and down as the load cushions deflect, but maintain lateral and fore and aft alignment of the saddles. For extra–heavy-duty applications, an additional round center cushion, as well as related brackets on each side of the chassis, is shown as item 22 in Figure 20–45. This option increases stability in oil field, refuse, transit mix, and logging operations.

Alignment of the RS series suspensions, if equipped with the shim-type bar pin beam end connections, can be performed by installation of selective shims, as was discussed under the subheading "Hendrickson Equalizing Beam Suspensions." Inspect cushions for cuts and swelling at least once a year. Cushions cut by the retaining lips of the saddles or frame hangers indicate that the cushions may not be the correct hardness for the specific application or may need rebound control with a rebound control stop kit. On transit mix and dump truck applications, a buildup of dirt or other material under the cushions escaping from the retainer lips on the saddles can cause twisting out of position. Also check the vertical drive bushings for signs of torn or shredded rubber at least once per year. In aluminum saddles, the allowable thrust washer wear is up to $\frac{3}{16}$ in. (4.76 mm) into the saddles as measured at the top of the thrust washer diameter.

Disassembly of the RS system is similar to that shown in Figure 20–43 for other equalizing-beam systems. The load cushions can be replaced without suspension disassembly by raising the frame and allowing the weight of the axles to open the area between the brackets. The cushions can then be forced out and replaced.

SOLID-RUBBER SUSPENSION

A number of suspension system OEMs offer a premium natural-rubber spring design that places the rubber springs under compression and shear to provide exceptional vehicle ride quality, loaded or empty. Suitable for both on- and off-highway refuse, dump truck, and logging vehicles, one example of a premium-rubber suspension system is shown in Figure 20–48. This Hendrickson HN Series design features the



KEY NO.	DESCRIPTION
1	Frame Hanger LHF/RHR (Includes Key Nos. 8,9) See 45745-037—Components Section
2	Frame Hanger RHF/LHR (Includes Key Nos. 8,9) See 45745-037—Components Section
3*	Load Cushion 40 Durometer 60 Durometer 70 Durometer
4	Saddle Assembly, 12¼" Height, Dim. 'A' (Includes Key Nos. 5, 6, 7, 10 to 15) (Casting No. 10711-1)
4	Saddle Assembly, 14" Height, Dim. 'A' (Includes Key Nos. 5, 6, 7, 10 to 15) (Casting No. 10711-2)
4	Saddle Assembly, 15¼" Height, Dim. 'A' (Includes Key Nos. 5, 6, 7, 10 to 15) (Casting No. 10711-3)
4	Saddle Assembly, 12⅞" Height, Dim. 'A' (Includes Key Nos. 5, 6, 7, 10 to 15) (Casting No. 10711-5)
5	Saddle Bearing Ring
6	Bushing
7	Cap
8	Washer
9	Nut
10	Stud
11	Nut
12	Saddle Cap
13	Stud
14	Washer
15	Nut, Saddle Cap Stud
16	See Equalizing Beam Assembly Parts List SP-128—Components Sec.

KEY NO.	PART NO.	DESCRIPTION
17		Center Bushing
	49400-000	RS-400
	49600-000	RS-400 w/Loose End Plug
	29483-005	RS-460/480/520
18		Cross Tube
	44643-009	RS-400/460/480 44⅞"
	07622-003	RS-520 46"
		Rebound Control Stop Nut I (Includes Key Items 19, :
	31005-001	One Side (Optional)
	31005-002	Both Sides (Optional on RS-400/460/480, Standard on RS-520)
19	30208-000	Rebound Bumper
20	30251-000	Stop Nut
		Heavy-Duty Load Cushion K Standard on RS-460/480/520 Optional on RS-400 (Includes Key Items 21, 22, 23)
	20681-072	34" Frame Width
	20681-077	34½" Frame Width
21		Frame Hanger
	48523-001	34" Frame Width
	48525-001	34½" Frame Width
22	24209-000	Heavy-Duty Load Cushion
23	20781-000	Saddle Plate
24	34013-087	Bar Pin Bushing Kit Non-Shim Type
25	34013-088	Bar Pin Bushing Kit Shim Type
26	32271-000	Torque Rod Assy.—See Note**
27	22186-000	Frame Brkt.—Torque Rod
28		Transverse Torque Rod Assembly (Includes Key Nos. 29, 30, 31, 32)
29	22186-000	Transverse Torque Rod Frame Bracket
30	50234-000A	Transverse Torque Rod Assembly
31	45045-003	Backup Plate
32		See 45745-031 for Proper Axle Bracket

FIGURE 20–45 Exploded view of an RS rubber–load cushion system. (Courtesy of Hendrickson Truck Suspension Systems.)

proven walking beam design with a high-quality bolster spring. This unique concept eliminates the need for a center bushing, which is widely used in equalizing-beam designs. This design offers superior ride quality to a spring-type system, and offers more stability than air ride systems. By positioning the rubber at the center of the equalizing beam, driving and acceleration forces are concentrated at a low center of gravity to enhance vehicle stability. Rebound control stops greatly contribute to increased stability during turns and off-highway operations by controlling vehicle roll. Axle alignment with this suspension system model is similar to that for models incorporating an equalizing beam design, since the bar pin end connection can be shimmed similar to that shown in Figure 20–45.

Another example of a rubber spring design is shown in Figure 20–49, which illustrates a unique rubber-spring concept known as a Dynalastic model. This system is designed for use on heavy-duty tandem drive trucks for refuse, military, firefighting, logging, and construction vehicles. Using an equalizing-beam design, the rubber–spring-cushioned torque beams are individually jointed for independent drive axle movement, eliminating brake hop and axle chatter.

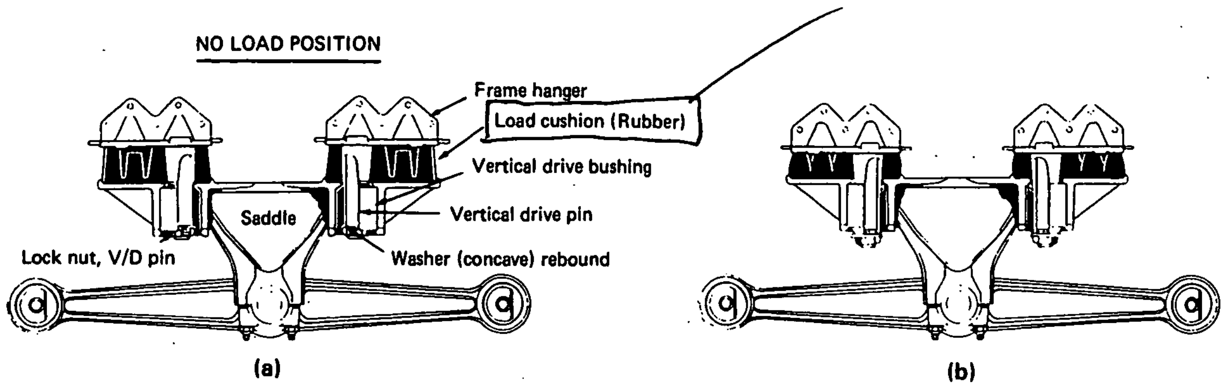


FIGURE 20–46 No load (a) and loaded (b) positions on the vertical drive pin of a rubber–load cushion suspension system. (Courtesy of Hendrickson Truck Suspension Systems.)

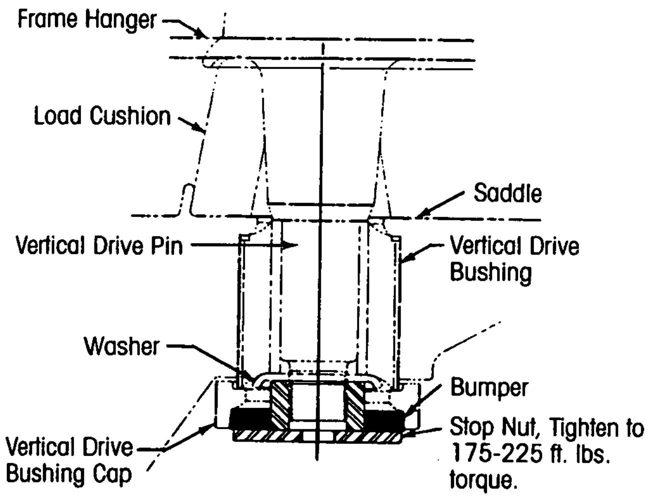


FIGURE 20–47 Close-up view of the vertical drive bushing and rubber–load cushion suspension system. (Courtesy of Hendrickson Truck Suspension Systems.)

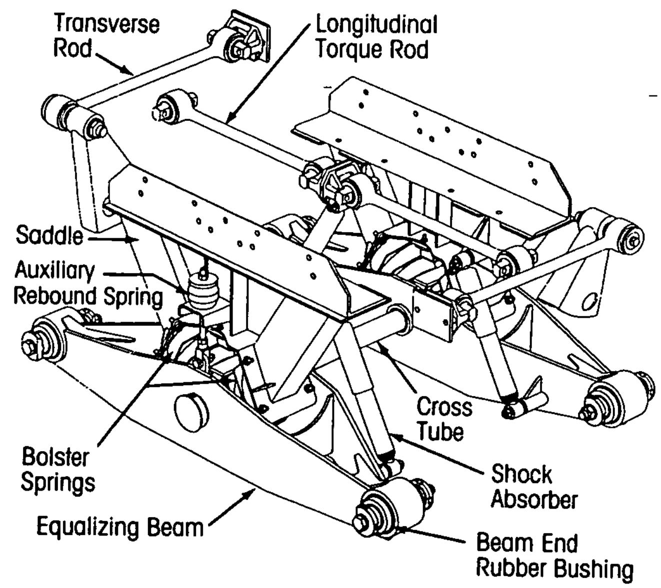


FIGURE 20–48 HN Model premium rubber suspension system design. (Courtesy of Hendrickson Truck Suspension Systems.)

In extreme service conditions where the tires act as the suspension springing connection, such as in combination on- and off-highway application such as severe service refuse, redi-mix, and logging vehicles, a solid-mount suspension such as the one shown in Figure 20–50 provides a superior connection between the frame and axles. This type of suspension system employs an equalizing beam with a high-confinement rubber center bushing. Bronze center and rubber end bushings are standard on higher-loaded vehicle models. Alignment can also be achieved by employing bar pin end connections similar to those discussed in this chapter and shown in Figure 20–50.

TORQUE RODS

Torque rods are an important integral part of any suspension system, since they not only control the installed angle of the axle assembly, but also absorb driving and braking forces. When used with certain models of suspension systems, such as the model shown in Figure 20–5, the torque rod (item 20) can be adjusted to align the axles to the frame. Normally, however, the torque rod mounting brackets at the axle ends are furnished and welded into position by the axle manufacturer, while the truck or trailer OEM positions the frame end of the torque rod to a bracket assembly.